National Aeronautics and
Space Administration

Christa's Lost Lessons

Chromatography

Grade: 5-8

For more of Christa's lessons and accompanying videos filmed in orbit, visit www.challenger.org/christa.

www.nasa.gov

Chromatography

Background Guide

Grade Level:
5th-8th

Suggested Time:
55-60 minutes

Standards:

- 3-PS2-2: Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.
- RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- WHST.6-8.7: Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Background

- **Chromatography:** The separation of a mixture into its individual components.
- **Mixture:** A substance made by mixing other substances together.
- **Capillary Action:** When a liquid, like water, moves upward to the cohesive and adhesive properties of the liquid.
- **Cohesion:** Particles of the same substance sticking together.
- **Adhesion:** Particles of different substances sticking together.
- **Gravity:** The force that attracts a body toward the center of the earth, or toward any other physical body having mass.
- **Soluble:** Able to be dissolved, especially in water.
- **Solvent:** Able to dissolve other substances.

Essential Questions

- What is chromatography?
- What is capillary action and how does it work?
- Why does one ink separate apart from another?

Objective

- Following this activity, students will be able to:
  - show how capillary action occurs in microgravity.
  - show how black ink divides into different colors through chromatography.
  - compare and contrast capillary action as seen on the International Space Station (ISS) and a classroom on Earth.

Materials

- Black ink pen
- Small strip of paper
- Test tube with lid, cork, or fastener
- Paper clip

Teacher Preparation

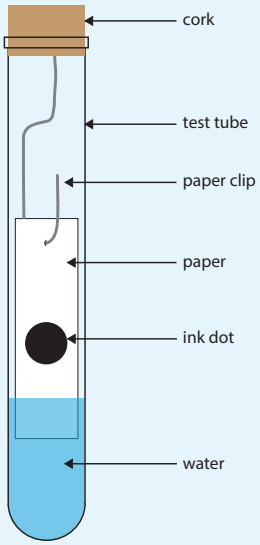
The objective of this lesson is to compare the effects of capillary action and chromatography in space to that on Earth. This experiment can be done in small groups or by demonstration in front of the whole class.

Gather your materials (listed on the previous page) and follow the design set up depicted to the right by placing a small ink dot toward the bottom of the paper.

Attach the paper to the paper clip. Bend one end of the paper clip and insert it into the cork.

Fill the test tube with a small amount of water. Make sure that there is enough water to get the paper wet, but not so much that the ink dot is fully submerged. Submerging the ink dot can potentially provide skewed results.

When performing the experiment, allow the paper to sit in the water until the ink starts to separate and different colors can be seen.



PROCEDURE

ENGAGE (10 min)

Materials needed: Ink pen or marker, paper

Opening Demonstration - Chromatography:

- In front of the class as an opening demonstration, draw an ink dot on a piece of paper and ask your students the following questions:
  - Do you think the ink in this dot has more colors in it than just the one you can see?
  - How would you be able to see other colors if there are any?
  - What do you know about the properties of water?
- NOTE: Additional engagement activities are listed below in the “Extensions and Enrichments” section.

EXPLORE (10 min)

Materials needed: Chromatography video: Find at www.challenger.org/Christa

Video Viewing:

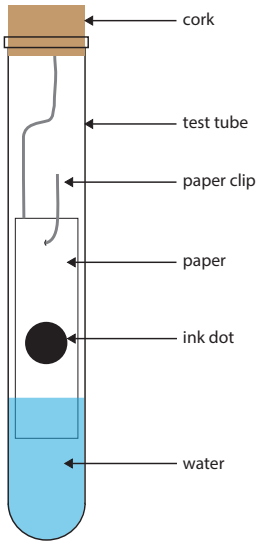
- At this time, show the designated video associated with the Chromatography lesson
- Students should observe/take notes during the video.

EXPLAIN (30 min)

Materials needed: Black ink pen or marker, small strip of paper, cork that fits the test tube, paperclip

In Class Experiment:

- Students should hypothesize their predictions of this experiment now that they are performing it on Earth. Have them record their predictions.
- Next, replicate the experiment in your classroom. You can do this as a class or in small groups. Small groups are recommended to allow students to perform the experiment themselves. Further, this allows groups to compare their results.
- Design the setup as depicted to the right by placing a small ink dot toward the bottom of the paper.
- Attach the paper to the paperclip and bend the paperclip so that one end is inserted into the cork.
- Fill the test tube with a small amount of water. make sure it is enough to get the paper wet, but not fully submerge the ink dot. Submerging the ink dot can potentially provide skewed results.
- When performing the experiment, allow the paper to sit in the water until the ink starts to separate and different colors can be seen.
- Have students record their observations and data.



Questions:

- What differences or similarities did you observe from the experiment in space versus the experiment in our classroom?
- What colors did you see on the paper after it was dipped in the water?
- Why do you think the water “climbed up” the paper?

ELABORATE (5 min)

Materials needed: If you like, you can provide a diagram of a plant structure or tear duct and reiterate the occurence of capillary action.

Chromatography and Capillary Action:

- Provide a definition/review of chromatography and capillary action to students.
- Chromatography: the separation of a mixture into its individual components.
- Capillary Action: When a liquid, like water, moves upward due to the cohesive and adhesive properties of the liquid.
- Explain how capillary action is essential to life. It is how plants get water from their roots to their leaves, how tears flow out of our eyes, etc.

EVALUATE (5 min)

Materials needed: None

Final Questions and Wrap-up:

- Do you think they would have been able to perform the experiment with test tubes in space? Why or why not?
- Do you think gravity effects how fast the water travels up the paper? Why or why not?
- How would you set up this experiment differently if you were in microgravity?
- Would this be more difficult in microgravity? Why or why not?

EXTENSIONS AND ENGAGEMENT

Chromatography Ground Experiment:
Christa's Chromatography Lesson
Additional opening activities are listed below to incorporate into the "Engage" section, time permitting.

DEMONSTRATION: Cohesion/Adhesion

- Place a piece of paper towel on a flat table. Add a few drops of water to the piece of wax paper. Ask students what they see.
- Add a few more drops of water to the wax paper. Ask students again to observe what they see.
- Add a few drops of water to the paper towel. Ask students to explain what is happening.
- Define cohesion and adhesion so that students have concrete background knowledge of this concept.

DEMONSTRATION: Gravity

- Ask students to define gravity.
- Demonstrate by having a student drop a pencil or jumping up and down.
- Prompt students with a discussion about what kept pulling them to the ground when they were jumping.
- Provide a concrete definition of gravity so that students have a thorough understanding.
- Gravity: The force that attracts a body toward the earth or another body having mass.

CHROMATOGRAPHY

INTRODUCTION

The chromatography experiment you are going to conduct would not be possible without cohesion and adhesion. This activity will demonstrate those properties.
Materials needed:

- Wax paper
- Paper Towel
- Pipette/Water Dropper
- Water

DIRECTIONS

1. Place the piece of wax paper and paper towel next to each other on a flat surface. Take the pipette/water dropper and add a few drops on top of the wax paper. What happened to the drops? Next, add a few more drops of water to the already existing water droplets. Record what you observe.

2. Repeat this process with the paper towel. Record what you observe.

REVIEW

1. Why do you think the water behaved differently on the wax paper than on the paper towel?

2. How would this experiment be different in microgravity? Explain.

CHROMATOGRAPHY

NASA Astronaut Ricky Arnold is going to perform an experiment that teaches you about chromatography on the International Space Station. Write down your observations as you watch the video.

Chromatography Experiment Video: Use the word bank to fill in the definitions below.

different	adhesive	dissolve	substances	same	dissolved
upward	cohesive	individual	permanent	separation	

Chromatography: The _____ of a mixture into its _____ components.

Solvent: Able to _____ other _____.

Indelible: _____, unable to be _____.

Capillary Action: When a liquid, like water, moves _____ due to its _____ and _____ properties.

Cohesion: Particles of the _____ substance sticking together.

Adhesion: Particles of _____ substances sticking together.

OBSERVATIONS

1. What happens to the ink when water is added to the bottom of the paper?

_____

_____

_____

2. Which ink spot had the most separation? Why do you think this is?

_____

_____

_____

CHROMATOGRAPHY

YOUR TURN

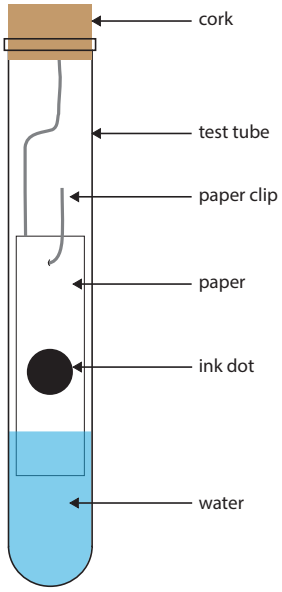
Now that you have seen what this experiment looks like in space, you are going to try it in your classroom. How do you think the environment in which this experiment is conducted will affect the outcome?

Hypothesize: Make your prediction about what you think will happen to the ink dot.

Materials: a black ink pen, a small strip of paper, a paperclip, a cork, water

DIRECTIONS

- Place a small in dot toward the bottom of the strip of paper.
- Attach the paper to the paperclip and bend the paperclip so that one end can be insterted into the cork.
- Fill the test tube with a small amount of water. Make sure that it is enough to get the paper wet, but do not fully submerge the ink dot. Submerging the ink dot can potentially provide skewed results.
- Allow the water to absorb on the paper. Be sure to keep the test tube upright so it does not tip over.
- Observe and record your data.



CHROMATOGRAPHY

DATA

What happened to the ink on the paper with gravity? Record your data here and compare it to the strip in microgravity. Draw a picture of the strips. Be sure to explain and label your data.

IN MICROGRAVITY (SPACE STATION)	IN EARTH'S GRAVITY (CLASSROOM)

CONCLUSION

What differences or similarities did you observe in the setup and results of the experiment in space versus the experiment in our classroom?

What colors did you see on the paper after it was dipped in the water?

Explain why the water "climbed up" the paper.

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